Smith (H. H.) *With the Compliments of the Author.*

ADDRESS

ON

CERTAIN POINTS IN THE PATHOLOGY OF BONES, ESPECIALLY TUBERCLE.

BY

HENRY H. SMITH, M.D.,

PHILADELPHIA, PA.

EXTRACTED FROM THE
TRANSACTIONS OF THE AMERICAN MEDICAL ASSOCIATION.

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ADDRESS ON SURGERY AND ANATOMY.

THE PATHOLOGY OF THE BONES.

MR. PRESIDENT AND MEMBERS OF THE AMERICAN MEDICAL ASSOCIATION:—

IN selecting a subject worthy of the consideration of this learned assembly, representing as it does, the erudition and experience of the Medical profession in the United States, I feel the responsibility of my position, and my inability to justly offer you any points for study, on which, many are not perhaps better informed than myself.

Had I yielded to personal wishes, I should not have intruded myself on your time and attention; but as your Nominating Committee and a vote of the Association have placed this duty upon me, I have sought to execute it to the best of my ability.

As Chairman of the Section of Anatomy and Surgery, the By-laws require me to prepare and read, in the general session of the Association, a paper on the advances and discoveries in anatomy and surgery, during the past year.

At the close of their Report in 1877, the Nominating Committee recommended a change in this By-law, suggesting "the preparation of an essay on some subject selected by the writer, in place of the former reports by chairmen; the reading of such paper not to occupy more than forty minutes."

Without presuming to anticipate the action of the Association on this proposed change, and with sincere distrust in my power to do justice to an extended question, in so brief a period as that assigned it, I venture to ask your attention to a pathological subject, which, whilst appropriate to the Section I represent, also presents points of interest to the entire profession.

Billroth has justly said,[1] that it is a happy advance in science, that there is no longer the same separation of surgery from medicine that formerly existed, and that there is in fact only an apparent distinction between them; the separation being artificial, though founded on history and the large and ever increasing literature of general medicine.

I trust, then, that in tendering you a few remarks on certain points in the PATHOLOGY OF THE BONES, ESPECIALLY TUBERCLES, I may be enabled to exhibit such physiological and pathological discoveries, as are pregnant with thought and may elicit useful, practical discussion.

In our elementary studies some years since, we, as students, were taught to regard the skeleton as "the bony framework of the body, and that its function was to afford points for the attachment of muscles, to form the joints, and protect the viscera." The Surgeon then considered the knowledge of this tissue as pertaining especially to his department, and to be limited to the study of the process of repair in injuries. *Now*, the bones have a more extended function assigned them, and are investigated microscopically, not only by the physiologist and anatomist, but, also, by the pathologist, *as one of the sources from which are furnished the white and red corpuscles of the blood*, and through which is introduced into the system, a materies morbi, that is closely connected with some of the most rapid and fatal disorders requiring the skill of the physician.

At present, leukæmia, or leucocythemia, pyæmia, septicæmia, and similar dyscrasiæ, have, in the opinion of many, a direct origin in the perverted action of the myeloid cells and lining tissue of bones, and the investigation of the truth of this doctrine is one of the problems of the present time.

In attempting to solve it, the examination of the elements found in the spongy tissue of bones, has become an essential point in a thorough autopsy; quite as much so as the examination of the condition of the spleen, liver, or lungs has always been. Now, until the cancellated tissue of some of the bones has been chipped, or cut out by bone nippers, and made by compression to yield the liquid matter that fills its cells, to microscopic examination, or, it has been decalcified, colored, and then placed under the field of the microscope in a thin section, we shall not

[1] Billroth, American edition by Hackley.

be possessed of all the knowledge a thorough investigation ought to furnish in some cases of diseased action.

It is especially to the German, Italian, and French physiologists that we are indebted for our knowledge of this new function of bone, though our own countrymen have not neglected their suggestions, but in several instances have strengthened and confirmed the views of their European co-laborers.

It has been well said that physiology is the basis of all sound pathology, and as the disorders of the bones present only modifications of, or departures from, the normal processes of growth and repair, their diseased condition must be constantly compared with the changes noted in the embryonic cells and functions.[1] From special anatomy we learn that the cancellæ of the spongy bones and the medullary canals of the long bones, communicate freely with the compact layer of bone, through the nutritious vessels and intervening Haversian canals. Every bone, even those composing the vault of the cranium and the mastoid portion of the temporal bone, presents, therefore, a large system of anastomosing tubes and bloodvessels (Plate I, Figs. 1 and 3), the existence of which, as well as of lymphatics, has been proved by fine injections by Bichat; by the numerous bleeding points seen when healthy bone is scraped, and by the passage of mercury through the lymphatic vessels accompanying the intercostal arteries from the ribs to the vertebræ, as shown by Cruikshank,[2] and admitted by Sœmmering, Breschet, and others. It has also been demonstrated that the canaliculi and reticulated tissue of bone, the canals of Deutsch, and corpuscles of Purkinje are formed of threads or fillets, around which the bloodvessels, both arteries and veins, anatsomose in countless capillaries, it being estimated that every point of a bone is brought within $\frac{1}{170}$th of an inch of a bloodvessel.[3] This minute distribution of bloodvessels in the cancellæ of the bone bears thus a close resemblance in vascularity, to the arrangement of the air-cells and pulmonary vessels of the lungs, though of course not so readily traced owing to the presence of the salts of lime and the consequent induration of the tissue.

In this medullary structure, which is so extremely delicate that it is compared by anatomists to an amorphous film, yet lines

[1] Cornil et Ranvier, Histologie Pathologique, Part 2, page 340.
[2] Anatomy of Absorbing Vessels, page 198. London, 1790.
[3] Horner: Special Anat., vol. i. p. 81, 1851.

the diploë and cancellated tissue of every bone, modern physiologists have placed *a focus for the origin and development of the white and red blood corpuscles*, from which, as well as from those of the spleen and lymphatic glands, the elements of the general circulation are being constantly renewed in health, or disturbed and vitiated in disease.

In order to make this more apparent, reference is necessary to some of the recent views of the anatomical relations of the structure involved in this new and important function.

According to Stricker,[1] the medulla of the fully developed long bones is composed of a delicate connective tissue, traversed by vessels, and containing numerous fat cells (yellow medulla), and has no osteogenic activity; but in the medullary spaces of the spongy or cancellated substance, there is found a reddish mass, traversed by numerous bloodvessels (red marrow), and presenting few fat cells but a large number of granular cells, similar to those seen in embryonic medulla. Amœboid movements also occur in these medullary cells, analogous to those seen in the colorless blood-cells. Large nucleated masses of protoplasm are also described by Robin as "myeloplaxes," and are most abundant in the external layer of the medulla that occupies the above cavities. These giant cells or myeloplaxes, proceed, as Bredichini thinks, "from the bone cells coincident with the absorption of the matrix, and are continuous with the formation of medullary canals during the growth of the bone. As the different sized medullary spaces of the bone are continuous with one another, so do the yellow and red medullæ gradually pass into one another."

That the internal structure of bones, and especially the medullary cells of the red marrow exercise an influence upon the blood corpuscles through the myelitic cells, and are even believed to be the seat of the changes of leucocytes into red-corpuscles, has been much discussed. Among the most prominent of those engaged in such investigations have been Neuman and Bizzozero.[2] Neuman of Königsberg, in 1869, in a paper with the title of "The significance of the marrow of bones in the formation of blood," having presented the two following propositions: 1*st*. "That there takes place in the vessels of the bone-marrow, favored by a considerable retardation of the blood current, a transformation

[1] Manual of Histology, by Powers, Sydenham Society, 1870, p. 145.

[2] Gazzetta Medica Italiana Lombardia, p. 381, *et supra*.

of abundantly accumulated *white* corpuscles into *red* blood corpuscles." 2*d.* "That a continuous passage of the medullary cells into the vessels, contributes to the accumulation of white cells in the bloodvessels of the marrow."

He also found, besides colored nucleated cells, a remarkable number of lymph cells (leucocytes) in the marrow, and that there were intermediate forms between the white and the red corpuscles, as well as other transitional forms that showed the transformation of the white blood corpuscles into the red nucleated cells, and indicated the change from these to the red non-nucleated cells.[1]

Eales, of Leipsic, in 1870, obtained similar results in the investigation of the marrow of young rabbits and the vascular red marrow of children, as well as in the spongy bones of adults.[2]

Neuman, confirmed by Eales, describes the blood forming structure as a remarkably developed capillary network, and a special tissue contained in the meshes of this network he calls the "*medullary tissue*," the capillaries of which have this peculiarity—that their calibre is, on an average, four times as great as that of the small arterial branches that immediately supply them; this sudden enlargement of the blood-channel causing considerable delay, or diminution in the velocity of the blood. Within the vessels, especially at their wider part, he saw a great accumulation of the white cells as well as transitional forms in variable proportions, and these, he thinks, mark out this locality as the seat of the blood metamorphosis. The red form, or as Neuman calls it, "the lymphoid medullary tissue" around the vessels, are said "to bear a marked resemblance to the cytogenous connective tissue of Kölliker, or the adenoid tissue of Wilhelm His of Basle."

According to Neuman, the lymphoidal cells of the blood are also formed in the medullary tissue, and find their way into the vessels by a process of *immi*gration similar to but the reverse of that of *emi*gration, described by Cöhnheim. Eales's researches whilst confirming this change, also proved that similar modifications of the corpuscles took place in the apophyses of the long bones, in the sternum, and in the diploë of the skull; thus establishing the medulla of the bones as one of the sources of the elements of the blood.

[1] Newman, as quoted in the Philada. Med. Times, March 1, 1871, p. 250.
[2] Ibid.

The fact of the influence exercised by the medullary tissue of bones upon the blood, as advanced by Neuman, has been strengthened by the observations of our own countrymen as well as by recent observations in Europe. In the United States, Dr. H. C. Hand, of St. Paul, Minnesota, has recognized[1] the usual normal existence of leucocytes (or granular cells of $\frac{1}{300}$ of an inch in diameter) in the red marrow of bones. As the myeloid cells of Virchow, and in the blood as its white corpuscles, or as the lymphoid cells of Neuman, or as the pus corpuscle in œdematous connective tissue, these leucocytes he thinks occupy diverse positions and fill diverse functions in the economy both of health and disease. How the red blood corpuscles, that arise in the marrow, find their way *into* the vessels, has been variously explained theoretically; but Dr. Hand regards it as readily explainable by the description offered by Mr. Gray, viz., that in the blood-making marrow, the vascular walls lose themselves in the formation of lacunæ, like the lacunæ of the spleen, and hence the entrance from these lacunæ into the vessel of the red corpuscles, is as easy as that of the white corpuscle.

In a valuable paper, by Dr. Horatio C. Wood, of Philadelphia, on Leucocythemia and Pseudoleukæmia, he alludes[2] to Neuman's views, and the question is asked, "Is there any change in the marrow of bone at all peculiar to leucocythemia?" and after quoting Neuman's case, in which the vascular network, as before described, and generally so richly developed in the medulla, was absent, he gives the result of an autopsy of a case of leucocythemia in which the lumbar vertebræ, on section, were a bright carmine red; contained various corpuscles, often not nucleated and granular, and the right and left femora presented in their medulla very little oil, very few red corpuscles, and an immense number of cells of $\frac{3}{120}$ to $\frac{4}{40}$ of an inch, the left tibia presenting a somewhat similar condition. Dr. Wood regards this as sufficient evidence that hyperplasia of the medullary cells is not improbable in scrofulosis, as well as in pyæmia. In another case the principal lesion was apparently the changes in the bone marrow. To the dyscrasia accompanying this no name has yet been given, though "Hæmic cachexia," as suggested by Dr. Wood, may be appropriate.

[1] Philada. Med. Times, Feb. 1, 1872, p. 164.

[2] Am. Journal of Med. Sciences, Oct. 1871, p. 378.

Dr. William Pepper, of Philadelphia, in a paper on "Progressive Pernicious Anæmia or Anæmatosis," also says: "It is probable that the bone-marrow, is connected with the process of transformation which the blood globules undergo either in formation or destruction; that there exists three forms of anæmia or leukæmia and pseudoleukæmia, viz., splenic, lymphatic, and medullary," thus showing the important influence of this recently discovered function of the medulla of bones on the general condition of the blood, and the relative number of the red and white corpuscles.

In an autopsy of a marked case he found "the marrow from the radius made up almost entirely of granular cells, round, or nearly so, varying in size from a diameter of $\frac{1}{350}$ to $\frac{1}{200}$ of an inch. A few of the cells were granular to a marked degree, and a smaller number contained a single drop of fat."

Orth,[1] in describing the post-mortem examination of the bones of the thorax, also describes "the marrow of the sternum as of a red color, even in adult life, and as often presenting leukæmic, tubercular, and other changes identical with those found in the bones of the extremities." But we are not limited to autopsies in proving the medullary changes in bones, as Paul Voigt explored a diseased sternum in a case of medullary leukæmia, and found the bone very soft, yielding to the canula a blood-tinged mass which contained a quantity of large white corpuscles, similar to those found in the blood; whilst red blood-corpuscles and oil drops were sparingly present.[2]

In the *Dublin Journal*, December, 1877, a case of pernicious anæmia, ending in medullary leukæmia, is reported from the German journal, the *Centralblatt* of the same year, in which "the medulla of the tibia was a drab-gray color, with solitary, large, liquid, purulent deposits, and smaller viscous and gelatinous spots, the latter being interspersed through the otherwise normal looking marrow; large round cells, with purple-shaped nucleus, solitary lymph-corpuscles, and red blood corpuscles also being present. Charcot's crystals were abundant, both in it and in the spleen. Hyperplasia of the medulla, the starting point of the pernicious anæmia, here became the starting point of the leukæmia."

[1] Pathological Anatomy, Am. edition (p. 105), 1878.

[2] London Med. Record, Aug. 15, 1877, from Berlin Klenisch, Dec. 1876. Medullary Leukæmia, by Mosler.

Dr. J. M. Purser, of Dublin, in a recent paper[1] on "Progressive Pernicious Anæmia," describes the post-mortem appearances, especially in connection with the medulla of the sternum, ribs, and lumbar vertebræ, in all of which it was of a soft consistence and reddish-brown color. The cancelli seemed larger and more numerous, and the bone trabeculi slighter and fewer than normal; whilst the medulla in the left femur resembled that in the spongy bones. There were no traces of yellow marrow. The medulla seemed to consist of colored and colorless cells, with transitional forms of all sizes. Myeloplaxes were not met with. His description of the tissue, he says, coincided with that of Cöhnheim, viz., red color, and absence of fat. Similar cells to those noted in the medulla were found in the liver and spleen; hence he concludes "that in pernicious anæmia there is probably an imperfect formation, and certainly an increased destruction of the red corpuscles, and that the products of this destruction pass off by the urine. This disordered action may be recognized before death by examining microscopically a drop of blood from the finger, and by ophthalmoscopic examination of the fundus of the eye, where ecchymosis will sometimes be found." In Mr. Purser's case, the bones of the cranium were dense and heavy, and the dura mater very closely adherent; but no account is specially given of the condition of the diploë.

As the Spleen has been long known to exercise considerable influence on the number of the white corpuscles of the blood, we might readily suppose, that if the medullary tissue of the bones also possessed such action, there would be a reciprocal relation between the bones and the spleen, and that extirpation of the latter, would be followed by a change in the action of the medulla of bones and of the lymphatic glands as the other sources of leucocytes. This has been established by Mosler and Shindler, who, in April, 1871, found, that after extirpation of the spleen, or artificially produced atrophy of that organ, the medulla of bones for a long time subsequently underwent a marked change resembling leukæmia, the function of the lymphatic glands also showing increased activity.[2]

The Spleen being admitted to influence the constituent elements of the blood in certain fevers, a similar action of the medullary tissue of bone, upon certain blood disorders, as erysipelas,

[1] Dublin Journal Medical Sciences, No. 71, 1877, p. 405.
[2] Centralblatt für die Med. Wissenchaften, May 13, 1871, No. 9.

scarlet fever, etc., is not only indicated by the complaints of patients in such expressions as "coldness; pain or aching in their bones:" or by popular names, as "break-bone fever;" but is also positively demonstrated by the most competent medical authorities.

Recent observations even go further and show that the disordered action in both the spleen and bone-medulla, may be the *cause* and not the *effect* of perverted action of the elements of the blood; Friederichs,[1] of Heidelberg, not only recognizing the influence of an enlarged spleen in diphtheria and facial erysipelas, but having also found a reciprocal action between the spleen and the general circulation; the tumefaction of this organ preceding, by five days, the development of a typhoid fever; whilst it disappeared as soon as health was restored. Of this, he cites the case of Dr. Von—— who had not been previously in any way exposed to a cause likely to induce an enlarged spleen.

Bearing in mind the close connection in function and the reciprocal action claimed by Mossler and Shindler, as existing between the spleen and the medulla of bones, we must also recognize the influence of the latter upon certain blood diseases, and admit as correct, the facts presented in the autopsies of leukæmia and pernicious anæmia before quoted. The well-known experiments of Hunter and Duhamel in coloring the bones of a young pig by feeding it on madder, the color being permanent for many months, also clearly prove the freedom of the circulation and the intimate reciprocal action of the bone-tissue and the general circulation. The rapidity with which food will thus color the bones was shown by Mr. Tomes,[2] who found one day sufficient to tinge the entire skeleton; consequently, less than one day would suffice for disordered action in the myeloid cells, to seriously affect the constituents of the blood and develop disease.

With these anatomical proofs of the intimate connection of the bone-cells and the blood, strengthened by several autopsies that establish the connection between the medullary tissue and the blood corpuscles, we can readily assent to the explanation now offered, why erysipelas, septicæmia, etc., so often ensue on operations that involve the bones; as, in these cases, the blood-form-

[1] Acute Splenic Tumor, and its Relations to Infectious Diseases, Sydenham Society, vol. 61, 1877.

[2] Todd and Bowman, p. 123.

ing function of the myeloid cells is impaired by the injury and the cell action which furnishes the general circulation with healthy elements, is so modified as to induce diseased and albumenoid blood; the first evidence of which appears near or around the seat of injury.

The knowledge of the influence of the myeloid tissue upon the general constituents of the blood, also presents an explanation of the curious result often noted after contusions and blows upon the head, of an apparently trifling character, but which are subsequently followed by abscess of the liver, or by serious nervous disturbance and pyæmia. Thus the diploë of the skull presents us in many cases with a remarkably well developed cancellated structure, traversed by the canals of Fleury[1] and lined by delicate veins that anastomose freely with the scalp and empty into the large sinuses near the base of the cranium as well as into the emissaries of Santorini; communicating freely through the porosities of the skull, with the superficial veins of the meninges of the brain (Plate I., Fig. 1). It is therefore easily understood, that, when a blow is sufficiently severe to induce congestion and ecchymosis in the diploë from a slight rupture of a vein, a clot forms: osteo-myelitis and phlebitis follow, and pus is soon thrown into the general circulation. Or, an increased number of leucocytes are produced and subsequently arrested in the lungs and liver as foci, that by retrograde metamorphosis develop the so-called metastatic abscesses.

Morgagni alludes to the influence exercised by the vessels of the diploë, when injured by the concussion from a heavy blow on the head when he says,[2] "Ut vascula, quæ inter tabulas medullæ subserviunt rumpantur et sanguinem fundant."

Velpeau sustained the opinion that the bones were often the points from which purulent infection originated.

Fayrer, of Calcutta, regards osteo-myelitis as one of the causes of pyæmia, and Holmes thinks pyæmia is often developed simultaneously with osteo-myelitis; but, with our knowledge augmented by Neuman's discoveries of the blood-producing function of the myeloid cells, we must regard the medullary tissue as the *fons et origo* of the diseased action excited by the blow.

If this is admitted we may readily doubt whether the practice

[1] Horner's Anatomy, vol. i, p. 170.
[2] De Sedibus et Causis, vol. i.

of modern surgeons, in neglecting the condition of the diploë, is as correct as those of a past century; many of whom are not spoken of reverently by the present age, because they recommended trephining and perforation of the diploë, in bone contusions.

The present age is in truth too apt to be disrespectful to those of the centuries which preceded it; forgetting that the man of to-day is the same physically as the men of the time of the Pyramids, or earlier; and that similar injuries produce very much the same results now as then, requiring the same principles and treatment for their relief; the main difference between the centuries being noted rather in the means of treatment, than in the principles that directed their application. History, as exhibited in numerous treatises on anatomy and surgery, distinctly proves that the ancient surgeons fully recognized the influence of the diploë; thus Celsus speaks of "granulations arising from the diploë;" and Heister, when speaking of corruption of the cranium says, "The surgeon ought to bore several holes through the bone, as far as the diploë, with an awl or other instrument;" evidently fearing congestion in this structure from falls or blows, where no fracture was created. In the "Medicinal Dictionary of all branches relating to Medicine," by Dr. R. James, published in three quarto volumes, in London, in 1745, under the article "OS," and referring to Pyæmia as at present known, he says, "The pus in internal inflammation of a bone, being retained in a warm, close place (medullary canal) will become attenuated, acrid, and putrid, and as there is no means for its evacuation, troublesome symptoms will supervene, and as an incision can be safely made into the bone, it should be perforated to its cavity, that thus the corrupted sanies may be evacuated."

Recently, a similar practice has been advocated by Böeckel of Ghent, who insists on the advantages to be derived from trephining *any* bone, and particularly those suffering from osteo-myelitis, after amputations. Too often, says he, "when a patient who has suffered an amputation, is taken with a chill, we regard him as lost, and folding our arms give him some internal remedy, and when the autopsy proves the existence of osteo-myelitis, declare it is secondary and produced by pyæmia, whilst in reality it is the suppuration of the medulla which abandoned to itself, and not treated energetically (that is freely evacuated by numerous applications of the trephine), ends by infecting the blood."

When on post-mortem examination we are desirous of recog-

nizing this now well-known disease in the diploë, we have an excellent characteristic appearance, suggestive of osteo-myelitis, as described by Orth,[1] viz., "a greenish-yellow or slaty discoloration of the sawed edge of the diploë, which is so marked as to prevent its being lost sight of in the small amount of cancellated structure sometimes present in the bones of the skull." On the other hand, the diploë may be fully developed or even hypertrophied to a marked degree (Plate I., Fig. 2), this condition being necessarily accompanied with greater vascularity and larger sinuses which, with the augmented cancellated tissue, must greatly modify the results of blows upon the skull, and the liability to blood-clot in the diploë.

In resections, amputations, compound fractures, and similar injuries involving the bones of the extremities, the function of the myeloid tissue is also impaired, and the vital force of the cells being thus weakened, the leucocytes soon degenerate into the well-known pus-corpuscle or ichor, and septicæmia supervenes.

As Virchow has shown[2] that it is only a short step from marrow to perfectly fluid tissue, and that the boundaries separating the medullary cells from pus cells cannot with certainty be defined, it is easy to comprehend the rapidity of the development of septicæmia after these operations, and the facility with which leucocytes and pus corpuscles may undergo retrograde metamorphosis, and pass into the general circulation after the development of perverted cell action in the myeloid cells from any of the causes just stated. When the septicæmic chill has appeared, the necessity of perforating the medullary cavity, and evacuating the pus should be promptly considered.

Another important result from suppuration in osteo-myelitis is seen when the modified nutrition of the epiphyseal cartilages of the young destroys the continuity of the diaphysis of the bone with its epiphysis; as when the epiphyseal head of the femur (Plate V., Fig. 4), separates from the neck of the bone in hip-disease, luxation of the femur or motion similar to that noted in false-joint, being subsequently induced by muscular action. But the extent of this portion of the subject precludes further reference to it on this occasion, and I can only hope to stimulate some who have the opportunity to its further elucidation.

[1] Diagnosis in Pathological Anat., Am. ed., p. 51. N. Y. 1878.
[2] Cellular Pathology.

Allusion has been previously made to the effects of fever on the sensibility of the medullary tissue of bones and the relief offered to "pain in the bones" (as noted in the cold stage of intermittent fever and some of the exanthemata), by surface friction, the application of a tourniquet[1] and other means of equalizing the superficial and deeper seated circulation. Similar results, indicative of the close connection and reciprocal action of the skin and medullary tissue of bones, have been recently most positively established in England, thus—Mr. Savory reports a case in which the exposure of a limb to sudden extremes of heat and cold, by plunging it into ice-cold or very warm water, caused acute osteo-myelitis, and Macnamara, of Westminster Hospital, cites[2] the case of a boy in perfect health, who fell through the ice Dec. 20th, and on Feb. 15th suffered amputation at the knee-joint, in order to prevent further absorption by extension of evident septicæmia. Dissection of the limb showed that the cancellated tissue and medullary canal of the tibia were entirely destroyed, and that the outer shell (compact tissue) of the bone was more healthy than any other part; the myelitis being evidently not due to extension of inflammation from the periosteum to the medulla through the Haversian canals, as might naturally be supposed.

The close relation of the circulation in the skin and that in the bones, is also exhibited in the valuable tables of Gibney of New York, hereafter referred to, where he cites[3] rubeola, scarlatina, varicella, vaccinia, and variola, with their respective sequences, as causes of bone and joint disease: thus—of 209 cases of Spinal Caries investigated with reference to this point, he found rubeola the exciting cause in 18 cases, scarlatina in 4 cases, vaccine in 3 cases, and in 106 cases of Hip Disease, the exanthemata were the exciting cause in 15. As Dr. Gibney does not refer to Neuman's observations on the blood-making function of the myeloid cells, he makes no reference to the view, just expressed, that the diseased action in the medullary tissue of the vertebra might be a cause and precede the development of the exanthemata in these cases, and not the *result;* just as the enlarged spleen, quoted by Fredericks, preceded the development of typhoid

[1] Wood's Practice of Medicine, vol. i. p. 240.

[2] London Lancet, May, 1877.

[3] N. Y. Med. Journal, vol. xxvi. No. 1, July, 1877, pp. 15, 18, 20.

fever. In other words, the diseased condition of the blood as expressed by the skin eruption, might have originated in these cases in the disordered action of the bone cells, these being primarily disturbed and the general circulation subsequently affected.

In analyzing the evidence thus presented by capable and careful observers in anatomy and physiology, we must admit that our present knowledge justifies our belief, 1st, in the probability of the cells of the medulla of bones, creating or influencing the creation of both the white and red blood corpuscles; 2d, that the medulla of the long bones and the cancellated tissue of the spongy bones present a loose connective tissue that readily develops pus: 3d, that through its proliferation of cells and vascularity, the medullary membrane readily becomes congested, and develops the inflammatory process; 4th, that under congestion, there is increased sensibility or pain in the bones, as complained of in intermittent fever, erysipelas, scarlet fever, etc.; 5th, that the product of this inflammation, especially pus, which so readily forms in the medullary tissue, may rapidly enter the circulation and create a dyscrasia and so-called metastatic abscesses; hence should be promptly evacuated; 6th, that the deficient action of the myeloid cells is closely connected with the development of leukæmia and pernicious anæmia; 7th, that "Hæmic cachexia,"[1] in many points, closely corresponds with the condition known as *scrofulosis*, and that this condition or similar disordered nutrition of the myeloid tissue leads to and aids the development of *tuberculosis*, and the retrograde action of tubercle in the bones.

Let us next study the special development and course of Tubercles in the bones, a disorder which, though long recognized and described by European pathologists, especially Nichet and Nélaton, has not been as systematically investigated in the United States; bearing in mind the fact that the general laws of tubercle are the same, no matter in what organ or tissue they appear, and that, consequently, a review of the doctrines at present held in reference to the production, characteristics, and progress of tubercles anywhere, will be the soundest basis for the consideration of their development and progress in the bones.

The minute study of tubercle is one of such extent, that I do not propose to tax your patience with a full account of its micro-

[1] Wood's Practice, vol. i. 251.

scopical characteristics; or the varied opinions held of its nature and origin.

The question "What is tubercle, and whence does it come?" has been often propounded, and offers, in a condensed form, the whole subject, and though the opinions hereafter quoted, show great diversity of sentiment on these points, numerous recent investigations and the evidence they offer, have greatly contributed to settle the question, viz., What is tubercle? Virchow describes[1] tubercle as "the growth of single cells of connective tissue by the degenerative proliferation of single groups of connective tissue corpuscles." In the formation of the higher forms of tubercle the new growth, he thinks, springs from the connective tissues; but in graver cases the cell-growth is associated with the lining of the alveoli and of the lymphatics, which accompany the terminal bloodvessels.

Wynne Foot, of Dublin, says,[2] "tubercles are small-celled overgrowths of lymphatic tissue (as in acute miliary tubercle), that have preserved such uniformity of size, color, and shape, as to have long since suggested the probability of their lymphatic origin."

D. J. Hamilton, of Edinburgh, says,[3] "to the naked eye tubercle, whether primary or secondary, forms a nodule the size of a pin's head, elevated above the surface, sharply isolated from surrounding tissue, and invariably of a rounded shape. Each nodule is composed of two or three or more 'giant cell' systems, and consists of masses of extremely granular protoplasm of a rounded or oval shape; frequently containing from ten to one hundred nuclei, and several nucleoles, in whose meshes lie cells of different kinds, each space of the reticulum generally containing a cell of one or the other variety, which are either epithelioid-leucocytes, or small giant cells; the whole system resembling very much the wonderful transformations seen in the amœba," the protoplasm being in his opinion endowed during life with similar powers of expansion and retraction.

Rindfleisch[4] says "we call tubercle (par excellence), singly and alone, a certain originally gray, translucent, very compact nodule, which is seldom larger than a millet-seed, but is found in many,

[1] Cellular Pathology, pp. 520 and 521.
[3] Dublin Journal, August, 1877.
[2] Edinburgh Med. Journal, p. 289, *et supra*, Oct. 1877.
[4] Path. Histology, translated by Kloman, etc. Philadelphia, 1872.

nay! innumerable numbers together. Cheesy degeneration and miliary tuberculosis very commonly occur side by side, the introduction of the cheesy detritus into the juices of the individual, resulting in the occurrence of miliary tuberculosis, and it is, therefore, a matter of indifference whether the cheesy material is transferred by inoculation, or arises in the organism itself. The smallest portion of the cheesy detritus is a poison, which by direct irritation, causes the tuberculous new formation of certain constituents of the tissues. This much, he says, is certain, the formation of a tubercle is the expression of a commenced dyscrasia; a corruption of the juices, which, in many cases, diffuses itself through the organism; in others is probably already congenital."[1]

Hamilton, of Edinburgh, says,[2] "the difference between the caseous or cheesy products of inflammation and true tubercle is the result of a retrograde process from the first in the caseous product; whilst tubercle becomes more highly organized instead of degenerating." The cause of the formation of tubercles he regards as the "absorption of the cheesy debris, which passes along a lymphatic vessel, irritates its endothelium, and excites it to proliferation."

Dr. Rodenstein,[3] of Yonkers, N. Y., maintains "the identity of the white blood-corpuscle with tubercle cells and regards tubercle as being caused by an extravasation of the leucocytes, an opinion originally stated by Addison in 1843, and more recently by Waldenburg."

As tubercles are usually developed along the course of blood-vessels, this, he thinks, is additional testimony to their origin from the blood. "As pus cells, leucocytes, and tubercle cells are identical, it is a special pathological cause which leads to the development of one or the other in any case." Wilson Fox[4] describes tubercles as "an overgrowth, or hyperplasia of lymphatic tissue, resulting from irritation of the lymphatic elements."

From all these opinions we may justly conclude, that tubercles are formed from the blood through the action of the lymphatic vessels; or by emigration of white corpuscles from the blood-vessels, to the latter of which they are often found attached, and

[1] Op. cit. at page 124.
[2] Edinburgh Journal, October, 1877.
[3] New York Medical Journal, December, 1871.
[4] Fox, Transactions Path. Society, London, vol. xxiv. p. 382.

as lymphatics are a form of connective tissue, we can harmonize Virchow's views with the others just quoted. Our previous investigations having shown the existence of lymphatics and bloodvessels in the bones, as well as the functions of the myeloid cells and cancellated structure, I think it must be admitted that there is in the cells of the spongy bones and the medulla of the long bones, the proper tissue to serve as a nidus for the creation and rapid development of tubercles, and that their development and progress in the bones, rest upon the same general principles as their development and degeneration in the lung, viz., formation along lymphatics and bloodvessels; development as cells, and disintegration by fatty degeneration, liquefaction and softening; their development being at first induced by an inherited weakness of cell action, or a pre-existing inflammatory caseous deposit.

The recent observations of Budge[1] have also proved by minute injections of Berlin blue into the periosteum of the bones of the metatarsus of the cow and calf, "that injected peri-vascular lymphatics surround the bloodvessels of the Haversian canals and that the bone lacunæ or corpuscles, are directly connected with them by their canaliculi, the injection showing that the radicals of the lymphatics of bone, are identical with the bone-corpuscles; lead by their canaliculi into the peri-vascular lymphatics of the Haversian canals and these empty themselves into the lymphatics of the periosteum," thus developing in a minute manner the existence and free anastomosis of bone lymphatics, around all the bloodvessels of bone, a fact originally noted nearly a century before by Cruikshank.

What special causes tend to the development of tubercles in the bones?

We have noticed the influence of congestion of the medullary tissue of bone on its cell proliferation and the increase of its sensibility, as well as on the number of its leucocytes; or, as Cornil and Ranvier[2] have said, "the formation of embryonic tissue in the medullary cavities." We can, therefore, readily trace the analogy between these and the similar results of congestion in the parenchymatous structure of the lung; especially, the formation of tubercles from a pre-existing unhealthy inflammation.

[1] Quarterly Journal of Microscopial Science, by Lancaster, London, Jan. 1878, p. 102, from the Archives.

[2] Anat. Pathologique, p. 205.

We have also seen that the defective elaboration of blood, or deficient anæmatosis, as described by Pepper,[1] was a result of perverted myeloid cell action, combined with disordered action in the lymphatic glands and spleen; and we may now ask, what is the difference between this defective anæmatosis and the condition long designated as *Scrofula* and what is the relation of *scrofulosis* to *tuberculosis* as in both instances the bones suffer. Pepper defines anæmatosis as "an affection of the blood-making tissues (spleen, lymphatic glands and marrow of bones) that causes defective elaboration of the blood; the changes in the blood consisting of a great reduction of its mass, with diminution in the relative proportion of the red globules, without increase in the white corpuscles; with probable changes in the vital properties of both the red and white corpuscles."

Scrofula is very much the same condition; but scrofula is unfortunately so imperfectly defined by writers, that it is difficult to recognize it as a specific pathological condition.

Dunglison[2] gives the origin of the name as from *scrofa*—a sow—because swine were presumed to suffer from a similar complaint; that is, in modern terms, the patients exhibited hyperplasia of the subcutaneous and other connective tissue cells, that caused swelling or thickening of the neck, like that of a hog.

Raige Delorme,[3] also ascribes the name to the resemblance of the knotted and swollen neck of those afflicted with scrofula, to the enlarged neck of the animal, and traces a similar explanation of the term to Hippocrates and Galen, all of which and innumerable other explanations give no expression of a true and distinct pathology.

In the nomenclature of diseases issued by the London College of Physicians, scrofula is defined as "a constitutional disease, resulting either in the deposit of tubercle or in specific forms of inflammation or ulceration."[4]

Percival Pott nearly a century since, regarding only symptoms, defined scrofula[5] "as an indisposition that occasioned a thick upper lip; a tedious ophthalmia; indurated glands in the neck and under the chin; a hard dry cough; obstructed mesentery;

[1] Am. Journal, No. cxl., p. 342, October, 1875.

[2] Dictionary of Medical Science.

[3] Dictionnaire de Médecine, xxx tomes.

[4] Howard, Chronic Bone and Joint Disease, St. George's Hospital Reports, vol. iv. 1869, p. 143.

[5] Chirurgical Works, vol. iii. London, 1783.

glairy swellings of the wrists and ankles; thickened ligaments of the joints and enlargement and caries of the bones, especially the vertebræ;" a description which is readily recognized even at present, as perfectly correct and in accordance with the extent of the pathological knowledge of his day and still admitted in ours. Owing probably to this want of a definite pathological description, as to what constitutes scrofula, a confusion of ideas has arisen; some contending for a specific disorder which is the result of a cachexia termed *scrofulosis;* others regarding scrofula as identical with tubercle, and scrofulosis, the same as tuberculosis, or the morbid state of the liquids—often congenital—which results in the formation of the growth called tubercle; or as Virchow has said, "of a pitiful production or new formation, that is miserable from its outset." It would be useless at present to attempt an extended account of this much vexed question, and I can only cite a few of the prominent pathological opinions published on this point.

Wagner,[1] in discussing the disordered conditions termed scrofulosis and tuberculosis, says "they are, by many, held to be identical; by others, to be different; but more recent investigations have shown, that there is no histological distinction between tuberculosis and scrofulosis; that scrofulous children become tuberculous, and that scrofulous new formations resemble the tuberculous not only of themselves, but, also, in their most frequent metamorphoses—cheesy transformation or simple atrophy."

Foot[2] says, "the two characteristics of tubercle and scrofula are, a tendency to chronic thick suppurations and irritability of the system of the lymphatic glands"

Rindfleisch remarks[3] "that the characteristic sickliness of scrofulous persons is especially shown by the easily induced inflammations of the mucous membrane that habitually disturb the lymphatic glands; either because the products of these inflammations contain something abnormal, or, because the glands in such constitutions are unusually irritable; the real relationship between scrofula and tuberculosis being the elaboration of a poison from the cheesy infiltration and from the suppuration, which, when absorbed, produces tubercle; the tubercle poison in most cases being manufactured by the patient himself."

[1] Wagner, General Pathology, 1876, pp. 458–9.
[2] Dublin Journal, August, 1877.
[3] Ziemssen's Cyclopædia, vol. v. pp. 637 to 639.

Hayward[1] defines scrofula, for practical purposes, "as a disease which manifests itself by a peculiar vulnerability and proneness of the subject to chronic inflammations of the mucous membranes and skin, lymphatic systems and bones: which inflammations are characterized by great pertinacity, and the products of which have a retrograde tendency." He thinks "it is quite distinct from tuberculosis, as scrofulous inflammation (chronic) often exists for years without any tubercles being found in the subject, whilst innumerable cases of tubercle are met with without a sign of any such chronic inflammation."[2]

Without attempting the settlement of the varied opinions of such authorities, I would simply express my individual faith in the idea, that the disordered nutrition designated as scrofulosis, is due to the blood changes created by perverted cell action in the true blood forming structures before named; that this is the result of an inherited or acquired weakness in the vital force of the tissue cells, and results in a condition similar to that described by Cohnheim, Wunderlich, and Wagner as "lymphatic pseudo-leukæmia," or the "leukæmia myelogenica" of Neuman, with or without splenic disorder, but frequently evincing perverted action in the cells of the myeloid tissue of bone. This is indicated by enlarged joints, diseased vertebræ, and arthritis coxæ vel genu, and enlarged lymphatic glands; the latter being partially the origin of the defective anæmatosis, subsequently noted.

If the ancient term Scrofula is to be continued, as seems probable, it should, I think, be simply regarded as expressing the external evidence of the pre-existing blood and cell disorder that results in imperfect nutrition and development of tissue; this pre-existing condition being designated as Scrofulosis.

Tuberculosis may or may not be connected with scrofulosis, and, according to Wagner,[3] "is a constitutional disorder, characterized by tubercle, as previously described; in which the deposit or formation (tubercle) after long duration, passes into cheesy atrophy and early softening, rarely appearing as a local affection. Its causes are partly hereditary and partly acquired, having been developed by insufficient food, bad dwellings, infection from a cheesy focus, the result of tuberculous inflammation, inoculation

[1] St. George's Hospital Reports, 1869, vol. iv. p. 146.

[2] Ibid, p. 147.

[3] Manual of Pathology, translated by Van Duyn and Seguin, p. 444.

and the ingestion of tuberculous masses as food," an example of which is found in the meat and milk of tuberculous animals, an interesting account of which was presented last year to this Association, by our fellow-member, Dr. A. N. Bell of New York.

Tubercle, when once formed in the bones, encroaches upon and occupies the place of the normal tissue in which it is developed, the capillaries becoming gradually obliterated in the process of its growth, and no new vessels, such as are developed in healthy inflammation (or that which is reparative in its tendency) being formed. Wagner also asserts[1] "that the obliteration of the capillaries near the seat of tubercle is due to the enormous new formation of nuclei around them, as well as from the increase of nuclei in the walls of the vessels."

Tubercles in bone, as elsewhere, may terminate, according to Rokitanski's well-known opinion, by withering, cretification or carnification, and caseous degeneration, softening or liquefaction; as well as by ulceration around its periphery; by which process an outlet is formed and the softened tubercle gotten rid of: or, "if the tuberculous mass remains inclosed or encysted, it undergoes desiccation and calcareous transformation; the fatty matter is decomposed into oily acids, as crystallized stearic acid and cholesterine, in the form of rhomboidal plates, the calcareous granulations forming hard concretions that can remain indefinitely."[2]

In the bones, tubercle may thus be evacuated by perforation of the compact layer, through periostitis, ostitis, and ulceration of bone; or it may escape into a joint (Plate III. Figures 1, 2, 3, 4) and develop intense acute arthritis and the subsequent evacuation of the joint tissues, by articular abscess.

According to Nélaton, tubercles in the bones, as in other tissues, are seen as *encysted* (Plate IV. Fig. 3) and *infiltrated* (Plate II. Fig. 1), each of these undergoing the usual change from crude to softened tubercle; in the course of which it is accompanied by inflammatory thickening, or even destruction of the part involved in the deposit.

In the long and thick bones, crude *encysted* tubercle is found in the cancellated tissue, where through inflammation of bone it creates a closed cavity (Plate IV. Fig. 3), the walls of which are lined by a membrane or cyst.

[1] Manual General Pathology, 1876, p. 450.
[2] Cornil and Ranvier, p. 210.

This cyst is soft and white on its internal face, but often pink on its outer surface from the presence of a vascular network, which increases in structure as the tubercle softens; in other words, there is vascular congestion of the cancellated tissue around the tuberculous mass. The osseous cavity thus created by tubercle, at first fits closely to the deposit, but enlarges with the progress and softening of the tubercle; becomes sinuous, sends out its sinuses in various directions, and terminates by various small openings (Plate III. Fig. 2) either on the periosteal surface of the bone, or into the articulation (Plate IV. Fig. 2). When evacuated, this tuberculous cavity heals very slowly, because the tubercles having pressed on the capillary vessels and displaced the medullary cells and cancellæ, none of the embryonic cells remain to create new bone, and the adjacent tissues are slow in recovering the healthy circulation that is essential to their vital action in the process of repair. The cancellated tissue around a tubercular cavity is often indurated or solidified (Plate II. Fig. 2 and Plate IV. Fig. 1), and shows a reddish circle of one or two lines in thickness, due to congestion and increased local circulation, like that seen in an inflammatory focus of the soft tissues. As encysted tubercle increases, it tends towards the surface of the bone; the periosteum increases in vascularity, and soon a new ossification may develop; creating osteo-phytes, and sometimes alteration of shape, so that the head of the femur may be greatly changed, especially at the points where motion causes the greatest friction of the articular surface (Plate III. Fig. 4). Sometimes the upper portion of the head of the femur appears perfectly flat (Plate III. Fig. 2), and the new shape is the result of fatty degeneration, softening of the bone corpuscles and the gradual attrition of the old bone;[1] aided by the creation of lactic acid, as a product of the arthritis, this acid favoring the solution and absorption of the carbonate and phosphate of lime in the bone-corpuscles. At other times, owing to interstitial deposit and erosion of the cartilages, the head of the femur or a portion of the acetabulum takes on a polish, like ivory (Plate IV. Fig 2), from the friction of the adjacent points and becomes *eburnated;* or a new ossification is established so as to serve as a barrier to the exit of the pus in its course to the surface of the limb (Plate III. Fig. 1).

When encysted tubercle is seated in the bone, near to an articular surface, the articular cartilage being but slightly organ-

[1] Orth, op. citat., p. 40.

ized (Plate I. Fig. 4) soon loses its vitality from diminished blood supply; is eroded and destroyed by *chondro-necrosis*, and the tuberculous pus may then pass directly into the cavity of the joint and develop acute tubercular arthritis (Plate III. Figs. 2, 3, and 4). This is one of the modes of the creation of arthritis coxæ tuberculosa, or so called *hip-disease;* or arthritis genu, or *white swelling*, as usually named. One of the frequent results of this arthritis, is seen in the adhesions contracted by the head of the femur with the bottom of the acetabulum, so as to fill it up (Plate V. Fig. 1); or on the dorsum ilii, where after separation from the neck of the femur at the epiphyseal junction, it forms a false joint, the old acetabulum being gradually obliterated by hypertrophy of the cancellæ around its margin (Plate V. Fig. 4).

In the Vertebræ, the inter-vertebral fibro-cartilages act like the articular cartilages of the joints; thus they lose their vitality from arrest of circulation; are destroyed by erosion (chondritis) and ulcerate by the removal of a central piece, "as if cut out by a punch."[1] The tuberculous pus then continues to extend its course through the cartilage, until by the destruction of the cancellated structure of one or more adjacent vertebræ, a considerable cavity is created at the expense of the bodies of the diseased bones, which, being then unable to sustain the vertical pressure, are crushed in the pus; which, with particles of tubercle and scales of molecularly necrosed bone, forms a pre-vertebral abscess by burrowing beneath the anterior vertebral ligament; escaping by the psoas or quadratus muscles by following the course of their respective sheaths.

Once evacuated, the osseous cavity created in a vertebra by softened tubercle, unlike that seen in the lungs, may be healed and obliterated by the approximation of the surfaces of the adjacent vertebræ, and the formation of bony spines (Plate VI. Figs. 2 and 4), though always with more or less deformity of the spinal column from the projection of the spinous processes; whilst the cavity in the bone is obliterated by the gradual thickening, granulations, etc., of the cyst membrane; thus creating a partial repair of the surfaces from which the loss has occurred. This spontaneous cure, by the cicatrization of tuberculous cavities in the bones, has been incontestably established by Nélaton.

In the *miliary* or *infiltrated* tubercle of bones, the tubercles at first resemble small, gray granulations, being pinkish and par-

[1] Nélaton, op. citat.

tially transparent; constituting a deposit in the cells of the cancellated tissue (Plate II. Fig. 1) analogous to that in which encephaloid deposits fill up the cells of connective tissue. After a varying period, these tubercles soften and are succeeded by a purulent infiltration and an interstitial thickening of the bone structure, like the thickening of the soft tissues around an abscess (Plate II. Fig. 2).

This thickening around the bone cells, by obliterating the interstitial nutrient bloodvessels, induces necrosis of the infiltrated bone, which, owing to its minute plates or scales, is often designated as caries, or more correctly as *molecular necrosis* (Plate VI. Figs. 2 and 3); though such a result may also be due to osteitis from other causes than tubercles.

Whilst, however, admitting that true caries and tubercular molecular necrosis may exist simultaneously, yet Nélaton[1] points out the distinction to be noted between the destruction of the cancellated tissue of bone caused by tubercle and that due to inflammatory caries, in the following comparison: "The cellular tissue of bone when infiltrated by *tubercle* presents us with interstitial hypertrophy; increased density and absence of vascularity; whilst in *caries* there is expansion of the bone-cells (rarefaction); softening and increased vascularity. *Caries* always proceeds from the surface, to the interior of bone; whilst *tubercle* passes from the centre to the periphery" (Plate VI. Fig. 2), a distinction easily made on post mortem examination and the condition commonly found in "Pott's disease."

The mode in which the deposited tubercle creates destruction of the bodies of the vertebræ and the adjacent inter-vertebral cartilage will be apparent from reference to the structure.

In the child, the bodies of the vertebræ are imperfectly ossified and separated by cartilage from the processes; the latter being only fused to the bodies about the fourth year.

The upper and lower faces of the bodies are also in the state of cartilage (Plate VI. Fig. 1), only being ossified about the fifteenth year; so that in early life, when the vertebral column is macerated, it is found that the bodies of the vertebræ appear as small rounded masses (Plate VI. Fig. 1), and that nearly one-half of the whole length of the spinal column is made up of cartilaginous epiphyses and inter-vertebral cartilages.[2] In youth, the ridge or mar-

[1] Op. citat., p. 31.

[2] Horner's Special Anatomy.

gin of the circumference of the superior and inferior faces of the bodies of the vertebræ is also an epiphysis (Plate VI. Fig. 1), and is not always fully ossified until adult age. The cancellated structure is fully developed in the bodies of the vertebræ, is very vascular, and presents veins which correspond with the diploic sinuses of the cranium, and are known as the sinuses of Breschet, who described them in 1819 (Plate I. Fig. 3). The inter-vertebral substance or cartilage, is formed mainly of concentric lamellæ, which are more abundant anteriorly than posteriorly, the fibres crossing in every direction and leaving intervals filled with a soft, pulpy substance, which in the centre is very soft (Plate VI. Fig. 1). This soft, pulpy mass is in a state of considerable compression and will rise up as a flat cone when a vertical section is made. This pulp is most abundant in early youth; diminishes concussion of the brain in falls on the feet, and concussion of the bodies of the vertebræ through the ribs, from blows on the chest, the head of the rib being specially sustained by it. It is well known, that this condition of the cancellæ of the bones of the young, exposes them especially to these disorders; thus Gibney, of New York, says,[1] Age is a predisposing cause, and furnishes a table of 5461 cases of joint disease during thirteen years (1864 to 1877), in which 84½ per cent., including the vertebræ, occurred *prior* to the fourteenth year.

Orth also describes[2] cheesy osteo-myelitis as occurring almost exclusively in children, the cancellated tissue being found filled with cheesy material, in the vicinity of which small tubercles may be plainly recognized.

Tubercles being then once developed in the cancellated tissue of the body of a vertebra, create a cavity, with consequent loss of bone substance. This cavity increasing as the tubercular mass softens, the pus perforates the centre of the inter-vertebral cartilage, and the body of a second vertebra becomes diseased. When the period arrives that the bodies of one or more vertebræ are reduced to a mere shell and unable longer to sustain the weight of the parts which they should support, they suddenly yield forwards, the spinous processes project backwards at an angle, and we have the deformity of antero-posterior curvature; this resulting from the mechanical force consequent on the vertical pressure on the bodies of the vertebræ and the inter-vertebral cartilage, by

[1] N. Y. Med. Journal, July, 1871, p. 9. [2] Op. citat., p. 384.

the weight of the head and upper extremities, as well as from the lesion induced by the flexion of the body, due to the weight of the thoracic and abdominal viscera, which we know are sustained by a healthy spine. The parietes of a tuberculous cavity in the body of a vertebra being approximated by flexion of the trunk, the tuberculous pus is forced out, the cyst becomes hypertrophied and undergoes fibrous changes, the anterior vertebral ligament and the periosteum by *periostitis ossificans* throws out bony spines or osseous splints, and these tend to support the spine and make up for the lost bone through anchylosis of adjacent vertebræ. (Plate VI. Fig. 4.)

The creation of these bony spines and processes from the anterior vertebral ligament and the periosteum, as well as the vertebral circular epiphyses, is also often seen in healthy men and animals that have been compelled in labor to sustain heavy burdens through the spinal column.

There has been much discussion of the question whether the affection and loss of substance in the inter-vertebral cartilage was primary or secondary; but, from careful study, I have long maintained the correctness of the opinion advanced by Nélaton, that the alteration of the inter-vertebral cartilage was consecutive to the destructive action in the bone. Anatomy also shows that the vitality of these cartilages is almost entirely due to the blood-vessels which reach their two faces *after* permeating the bone structure, and these vessels being previously compressed or obstructed by the tuberculous mass, the supply of blood to the cartilage is interrupted, it ulcerates in its centre, and subsequently dies and is macerated in the pus; whence the odor which attends the evacuation of pus from diseased vertebra. The cancellated structure of the body of a vertebra being also exceedingly vascular in childhood, and its cells filled with a carmine red substance which is extremely vascular, giving but little evidence of the grease or marrow seen in the short thick bones elsewhere, it appears to be specially prepared for tubercular formation.

True miliary tubercles, according to Billroth,[1] at first gray but susequently caseous, sometimes are developed in the vertebræ as the result of "*osteitis caseosæ*," this being consequent on the caseous degeneration that follows inflammatory neoplasia; por-

[1] Billroth, Pathol., Am. edition, p. 420.

tions of the necrosed bone, mixed with the cheesy pulp, filling the cavity so as only to be diagnosed when the caseous pulp is evacuated through an external opening.

In the long bones we find tubercles most frequently developed in the epiphyses, as the head and condyles of the femur, or in the head of the tibia; these bones in children—like the vertebra—presenting a large amount of red cellular tissue or red marrow. The extremities of these bones are the usual seat of tubercle, though it is occasionally, though very rarely, also found as encysted tubercle, in the shaft. When tubercle is developed in the extremity of a long bone, it is generally situated in the centre of the spongy or cancellated tissue of the extremity, where the bone is expanded to form the joints. Usually, tubercles when here developed, spread in every direction (Plates III. and IV.) tending towards the cavity of the joint as well as to the periphery of the bone just outside the articulating ligaments.

If, in its progress, it reaches the surface of the bone *outside* the joint, it breaks into the adjoining connective tissue, an abscess forms, discharges, and leaves a fistulous canal with a tit-like orifice in the skin; the tuberculous cyst is obliterated by granulations, and a spontaneous cure, after a time supervenes. If on the contrary the tuberculous softening and suppuration *enter* the joint, either in consequence of the proximity of the joint or the growth of osseous lamellæ consequent on the osteitis or periostitis, preventing its escape outwardly, sudden and severe arthritis supervenes accompanied by grave general symptoms, and followed by disorganization of the articulation. (Plate V. Figs. 1, 2, 3.) Such results are of sufficiently frequent occurrence when tubercles run their course either in the head or condyles of the femur, inducing acute hip-disease or white swelling of the knee.

Nélaton relates such a case in which a child aged twelve, after complaining of the knee-joint, though able to execute many motions of the limb, suddenly complained of intense pain, which was followed by marked external redness, a swelling of the knee, and the formation and evacuation of an abscess, this discharging a liquid tuberculous pus, that eventually caused death. At the autopsy, Nélaton found "the joint full of pus, with a circular perforation in the cancellated tissue of the condyle of the femur at a corresponding point, and a globular cavity lined by a very vascular membrane, half a line in thickness. Around this

perforation, the articular cartilage had not been materially changed, but it had lost its usual polish; whilst the synovial membrane presented all the evidences of arthritis." In another patient he saw "tubercular perforation consequent on lobular pneumonia that followed measles, the sudden appearance of arthritis being taken for rheumatism."

In another case a coxo-femoral arthritis was announced by a sudden and violent pain in the hip, numerous abscesses supervened, giving exit to a serous pus containing flocculi of tubercles, which, after a long period, was cured.

In these varieties of the progress of tubercles in and near the joints, we can readily trace, says Nélaton, the resemblance in their course, to the perforations caused by tubercles in the lungs. In one case, "acute pleurisy is suddenly developed by tubercles softening and opening beneath the pleura; just as acute arthritis supervenes on tubercles opening into a joint; whilst in the peri-articular abscess created by tubercle we see a repetition of the process, by which, owing to adhesions forming between the pleura pulmonalis and costalis, the softened tubercle remains in the lung substance, and is evacuated through a bronchus."[1]

In the peri-articular tuberculous abscess, comparatively little injury is done to the articular surfaces and fair motion may remain. In the other instance, necrosis supervenes and adhesion of the articular faces, or anchylosis, is established.

In reviewing now this portion of our subject, I think it will be admitted, 1st. That tubercles, either miliary or encysted, are closely connected with the lymphatics, or result from the "*lymphangitis nodosa*" of Rindfleisch, and may be formed by or developed through the lymphatic and capillary vessels found in the cancellated structure of the bodies of the vertebræ, in the epiphyses or extremities of the long bones of both extremities, as well, as in the spongy bones of the wrist and ankle joints. 2d. That the development and progress of these tubercular deposits, whether preceding or consequent on "caseous osteitis interna," is the same as in other tissues. 3d. That in all cases, tubercles arise in the vessels of the cancellated tissue of bone and *not* in the ligaments or articular cartilages; the ligaments or white desmoid tissue being sparingly supplied with blood vessels and these chiefly capillaries. (Plate I. Fig. 4.) 4th. That the destruction of cartilages and liga-

[1] Nélaton, op. citat.

ments, especially the round ligament of the hip-joint, is the *effect* and not the cause of impaired nutrition, their supply of blood being chiefly derived from the adjacent bloodvessels in the bony structures near them. 5th. That softened tubercles tend rather to intra-articular than periosteal or peri-articular evacuation. 6th. That in softening of tubercles, there is always congestion and inflammation of the bone-cells immediately around the seat of the deposit and that this results in more or less extensive molecular necrosis of the structure involved. 7th. That the perverted medullary cell-action, consequent on the formation of tubercle, reacts on the formative power of the myeloid cells and modifies the blood-corpuscles; thus proving that, when *general* tuberculosis appears, or the constitution is invaded, it *follows* rather than precedes the bone disease. Lastly, that scrofula means the evidence of defective anæmatosis or hæmic cachexia, dependent in a great degree on disordered action in the myeloid cells.

Now the practical lesson deducible from all this is, that we should "hold fast to the landmarks of our forefathers" and ponder on the expressions of those who, like Franciscus Delaboe Silvius in 1695, held to the lymphoid origin of tubercle; or Portal, who, in 1809, expressed the opinion that tubercles were formed by engorgement of the lymphatic glands as well as by lymphatic swellings of the cellular tissues of the lungs; or Broussais, who regarded tubercles as the result of chronic inflammation of the pulmonary lymphatics;[1] or of Percival Pott, who, nearly a century since, after a thorough investigation of the subject of scrofula in the bones, announced opinions the soundness of which has not yet been disproved, though greatly ignored by some surgeons of the present day. Speaking of antero-posterior curvature of the spine, Pott says,[2] "The true cause of this disease is a morbid state of the spine and some of the parts connected with it; which distempered condition will, upon careful inquiry, be always found to have *preceded* the deformity some length of time. In infants [children] this is the sole cause, and external violence has nothing to do with it. In the adult, I will not assert that external mischief is always and totally out of the question; but I will venture to affirm, what is equal, as far as

[1] Dublin Journal, 3d Series, No. lxvii. July 2, 1877, being lectures delivered by Arthur Wynne Foot, before the King and Queen's College of Physicians in Ireland, February 19th and 26th, 1877.

[2] Chirurgical Works, London, 1783.

regards the true nature of the case, which is, that although accident and violence may in some few instances be allowed to have contributed to its more immediate appearance, yet the part in which it shows itself, must have been previously in a morbid state and thereby predisposed for the production of it, as no degree of violence whatever is capable of producing such an appearance (antero-posterior-curvature) unless the bodies of the vertebra were by a previous distemper disposed to give way."

When we thus note the opinions of one whose study of the disorder has been so universally recognized as to have attached his name to the complaint,[1] and who wrote thus positively, in opposition to the Traumatists of his day, and when we recall the similar discussions of the subject within the last few years, we may exclaim with Ecclesiastes, "surely there is nothing new under the sun that hath not already been in the old time." If the experience of our fore-fathers in surgery is not to be entirely ignored; if pathological demonstrations have any practical value; if the anatomical description of the growth and development of the spine is not a fiction—I think it is incontestably established that antero-posterior curvature of the spine *is* consequent on the destruction of the cancellated tissue of the bodies of one or more vertebræ from a pre-existing caseous deposit that develops osteitis and ulceration of bone in the natural tendency to evacuation of softened tubercle. The opinions of Percival Pott have also been recently sustained by statistics, Gibney of New York, in an extended and valuable paper,[2] showing that out of 860 cases of joint disease including caries of the vertebræ, no cause such as a blow, fall, or other injury, could be ascertained in 483 who were closely questioned, and in 107 cases of knee-joint disease not a single case was found with a clear record[3] from scrofula. He therefore expresses the opinion[4] that every case, supposed to be traumatic, was vulnerable by a predisposition and was simply induced by traumatism as the exciting cause.

Billroth expresses a similar opinion when speaking of chronic inflammation of bone, which he says[5] "is chiefly due to constitutional dyscrasial disease, and although injuries, blows, falls, etc. may be the exciting cause, the ultimate cause must lie in the injured part or the system at large, otherwise it would take the

[1] Malum Pottii.
[2] New York Journal, July 1877, p. 6.
[3] Ibid, August 1877, p. 130.
[4] Ibid., August 1877, p. 151.
[5] Surgical Pathology, by Hackley, 1871, p. 414.

course usual to traumatic inflammations and soon terminate"—thus repeating the surgical opinions of the preceding century, and strengthening the position of such modern surgeons as recognize a pre-existing cachexia in all cases supposed to be caused by injury; "the injury being only the spark that lights up in the bone or joint, an inflammation of a destructive or unhealthy character, instead of one that was healthy or reparative in its tendencies."

It is an instructive instance of the tendency of "history to repeat itself," to find the discussions of to-day—whether Pott's disease originated in a local or constitutional cause—only a renewal of the ideas of a past century; whilst the treatment of antero-posterior curvature of the spine by Suspension, is but a repetition of a former practice. Nearly fifty years since, J. K. Mitchell, of Philadelphia, employed it, and the points to which swings were attached by him can yet be found in that city. Suspension,[1] the principal and main portion of the apparatus for which is regarded as a modern discovery, was also recommended and published, with an illustration of the apparatus, by Francis Glisson, M.D., in London, in 1660, so that it is now more than two hundred years old.

After describing the swathing bands, Glisson says:[2] "it is a pleasure to see the child hanging pendulous in the air and moved to and fro by the spectators." Though thus lauded at first, subsequent experience so slightly sustained its claims to confidence as a remedy, that it was forgotten, until recently revived as an improved mode of treatment. There is, however, another point of a practical character which was highly esteemed by the older surgeons in these complaints, that modern practice has too much ignored. I allude to the value of counter-irritants in deep-seated osteitis, especially of the caseous variety. In spine disease, Pott insisted[3] on the advantages derivable from "a large discharge of matter by suppuration from underneath the membrana adiposa, on each side of the curvature, by an issue, and advised the maintaining of such a discharge until the patient was well." Glisson in 1668, also says:[4] "Issues in this disease are much approved, and we have known some children cured only by the help of this

[1] London Lancet, Feb. 2, 1878, as quoted by N. Y. Med. Record, March, 1878.

[2] A Treatise on Rickets, by Francis Glisson, Geo. Bate, and Ahasuerus Regemoster, Doctors of Physick, London, 1668, p. 363.

[3] Op. citat., p. 415.

[4] Op. citat., London, 1668, p. 313.

means." Although modern surgery almost entirely rejects the remedy, yet I think there are few physicians who will not admit the value of flying blisters, sinapisms, tincture of iodine, and stimulating linaments applied near the clavicles in tubercular disease of the apices of the lung.

When we also recall the cases of Messrs. Savory and Macnamara, as before stated, in which osteo-myelitis was induced by variation of temperature applied through the skin, it is very evident that decided counter-irritants applied to the surface of the limb or a diseased bone or joint, must exercise a marked influence on the local congestion and diseased cell action existing in the cancellated tissue of the bone. Similar principles may be justly urged as applicable to the treatment of arthritis coxæ or hip-disease, which has been shown to be due to ostitis interna from caseous and tubercular deposit in the cancellated structure of the bones forming the articulation.

In such cases, our distinguished countryman, Dr. Physick of Philadelphia, at the early part of this century, secured perfect rest of the articulation by a carved splint; but he also laid much stress on the importance of general treatment in diminishing the internal congestion, insisting on the regular and long-continued use of purgatives; administering the compound powder of jalap of the Pharmacopœia twice a week for eighteen months continuously, if requisite. Nor was such treatment otherwise than useful, especially when combined with ferruginous tonics and good food, and I have over and over again, thus treated feeble, scrofulous children, with arthritis coxæ, and had them improve in flesh and color, instead of becoming exhausted by purging. I cannot but admire the improved splint for hip-disease of the present day, by which the articulating faces are kept at rest, and separated from the adjacent points of friction, whilst the patient benefits by fresh air and moderate exercise; but years of experience have only confirmed me in the correctness of the opinion, that no matter what splint is employed, regular purging and a general alterative and tonic treatment greatly contribute to the cure. Tubercles in bones—whether in the hip-joint, vertebræ, knee, or ankle, certainly require a general treatment (such as is applicable to tubercular phthisis), in addition to the purely mechanical appliances that prevent motion in the joint, and the general verdict of the profession is in its favor. Special means of doing this, have from time to time been highly lauded. Thus Hufeland in

1829,[1] recommended muriate of baryta, as well as the muriate of lime, in doses of ten to fifty drops of a solution of f℥ss to f℥j of distilled water and syrup, and professional attention has been recently directed by Robert Bell, of London, to the chloride of calcium, as directly influencing assimilation and nutrition, the most convenient form of administration being, he says,[2] a solution of the salt of which the dose for an adult is twenty to fifty minims in milk or syrup, both of which are worthy of trial as alteratives. Some of the mechanical appliances for keeping the diseased bones at rest, like the plaster jacket recommended by our distinguished member from New York, are excellent for splints and have gained for his practical skill the plaudits of two continents; but it is certainly not fully adapted to the treatment of these cases, without the constitutional remedies which all appreciate *as modifying congestion and inflammation at the seat of the disease.* On this point, that is, the importance of other treatment than mechanical appliances, surgery and medicine occupy common ground and highly appreciate the value of general and local medication in modifying the vitiated cell action and blood disorder, and it cannot be too forcibly asserted, that the separation of internal from external remedies, is apt to prove injurious; the internal treatment tending to delay or prevent the development of the tubercles in the bones, whilst the mechanical appliances only limit the deformity or the destructive action, consequent on their retrograde metamorphosis in the affected part.

Whilst however we admit the similarity of the principles involved in the treatment of tubercles anywhere, we cannot fail to recognize the advantages sometimes possessed by the surgeon, in the mechanical treatment of tubercular deposits in the bones; as his resection of a necrosed joint, in its last stages, may eradicate the local disorder, check hectic fever, and prolong life; whilst unfortunately the physician, in treating the advanced stage of phthisis pulmonum, is unable to keep the affected organs at rest, or remove the diseased structure.

Attempts have, it is true, been recently[3] made (1878) to apply remedies directly to the interior of pulmonary cavities, by passing a long trocar through the intercostal tissues and injecting

[1] On the Scrofulous Disease, translated by C. D. Meigs, 1829, p. 126.

[2] American Medical Record, Dec. 1877, from London Lancet, Aug. 1877.

[3] Dr. Wm. Pepper in M. T., May, 1878.

ɱxxv of a diluted Lugol's solution of iodine ɱxij to fʒj; Dr. Pepper of Philadelphia having at present thus treated[1] *fourteen cases*, in which twenty-five, or even a larger number of distinct injections were made without hemorrhage or any accident ensuing in a single case. These results are so favorable as to make an *era* in the treatment of phthisis pulmonum, and justify further trial.

Dr. Pepper has also likewise injected circumscribed spots in two cases of consolidation of the lung with apparent benefit, and will soon publish his experience.

Whether it would be wise or safe to aspirate a diseased vertebra, in order to hasten the escape of the lardaceous or caseous pus; or, as proposed by Bransby Cooper, "to inject phosphoric acid diluted with an equal weight of water, to expedite the removal of the moleculary necrosed bone;" or lactic acid that would make a soluble lacto-phosphate of lime; or to evacuate the products of the arthritis in hip-disease, in addition to the other means of treatment, is one of those problems that yet remain to be solved, but which I think may yet be accomplished without difficulty by any good anatomist.

The evacuation of softened tubercle from the head and neck of the femur by perforation of the cancellated tissue through the trochanter major, is one step in this direction, and worthy of further investigation, it having been shown[2] in 1868 to the British Medical Association by Dr. Fitzpatrick, of Dublin, that it could be advantageously performed. The case was "a young man whose wasted buttock—obliterated fold of the nates, etc.—proclaimed hip-disease," in whose trochanter Dr. Fitzpatrick made a *deep* issue by caustic potassa cum calce, on March 22, the flexion of the limb being of three months' duration. On the ensuing May 11th, seven weeks subsequently, the contour of the limb was restored, the patient could walk, and his general health was greatly improved.

In conclusion, I thank the Association for the patient consideration accorded to my subject, which, whilst not claiming originality, may yet, it is hoped be found to offer "such a review of the facts collected by pathological writers of the present time, as

[1] Am. Journ. Med. Sciences, Oct. 1874. Treatment of Pulmonary Cavities by Injection, by Wm. Pepper, M.D.

[2] Biennial Retrospect, New Sydenham Society, 1867–68, p. 261, *et supra*.

will enable you to deduce therefrom legitimate conclusions of practical importance."[1]

Perhaps it may also induce a more extended investigation of such general principles as alone can safely regulate the practical efforts of every surgeon, as well as physician, especially in this class of disorders, the physician, in our extended country, being often expected to unite all professional knowledge and accomplishments in one—often over-taxed—mind and body.

[1] Ordinances of the American Medical Association.

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The following works, for the inspection of many of which I am indebted to the courtesy of Surgeon-General Barnes, through the marked attention of Surgeon J. J. Woodward, U. S. Army, in charge of the very valuable and extensive medical library at Washington, have been freely used in the preparation of this paper.

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EXPLANATION OF PLATES.

THE following illustrations, the artistic accuracy of which is apparent, have been drawn from nature and on stone by Dr. Hubert Præger, of Philadelphia.

The preparations have been taken from the collections known as "the *Wistar and Horner Museum*" of the University of Pennsylvania at Philadelphia, and the "*Mütter Cabinet*" of the College of Physicians, an ancient medical society in the same city. The drawings from the first-named collection are designated by the letters U. P., University of Pennsylvania; those from the second collection by the first letter of the bone—as F. for femur, and the letter M. indicating the Mütter Cabinet.

Excellent as are the drawings, the specimens from which they are taken are necessarily much more instructive, and can be seen on application to the Curators of either collection on specifying the number and marks attached to each preparation.

PLATE I.

Illustrations of the Blood Supply in the Cancellated Tissue of the Cranium, Vertebræ, and Femur.

Fig. 1. *The Sinuses of Fleury, in the Diploë.*—These Sinuses show the free blood supply of this structure and the communication of the diploic veins, through various foramina, with the sinuses of the dura mater. The outer or compact layer of the cranium has been carefully removed, and the sinuses of Fleury colored by Prussian blue. One or more "torculares," or cavities in the bone made by the junction of the sinuses, are seen, and illustrate the facility with which *thrombi*, *pus*, etc., could accumulate at these points after severe contusion of the bone, and pass into the general circulation, unless arrested in the lungs or liver, as so-called metastatic abscesses.

From Preparation No. 211, U. P.

Fig. 2. *Hypertrophy of the Diploë.*—The Diploë of this cranium was $1\frac{1}{2}$ of an inch thick, and the outer table presented numerous foramina resembling ulcerated points which communicated with the diploë. The subject was a negro lad, about fourteen years of age, and with no evidence of syphilis. Like many of his race he was probably tuberculous, and was remarkable for "butting" his head against hard objects. Whether this caused the diseased bone, or not, is unknown; but with such a development of diploë the sinuses must also have been much enlarged and the bone circulation greatly augmented.

From Preparation No. 704, U. P.

Fig. 3. *Sections of Dorsal Vertebræ.*—These sections exhibit the large sinuses found in the cancellated tissue of the bones, and their communication through the foramen on the posterior face of the spinal canal, with the veins of the meninges of the spinal cord. Tubercles in this structure would necessarily modify the circulation in the medullary tissue of the bone, as well as induce congestion of the meninges of the cord, thus creating a tendency to paralysis of the legs.

From Preparation No. 406, U. P.

Fig. 4. A view of the Articular Cartilage and Round Ligament of the Femur, showing their connection with and nutrition from the bloodvessels in the cancellated tissue of the head of the bone. The capsular ligament has been cut off close to its insertion, and the articular cartilage separated and turned back from the round head of the femur, thus exhibiting the source of the blood-supply to the cartilage, and showing how readily the cancellated structure of the head of the femur would unite with that of the acetabulum and create anchylosis, when ulceration had destroyed the articular cartilage of each surface of the joint. A transverse section of the inferior portion of the head of the bone exhibits the origin of the round ligament and its connection with the cancellæ from which it is nourished. Tubercles in the cancellæ, by compressing the vessels of supply to the round ligament, would soon induce its necrosis.

From a Wet Preparation, U. P.

PLATE I

Fig. 1.

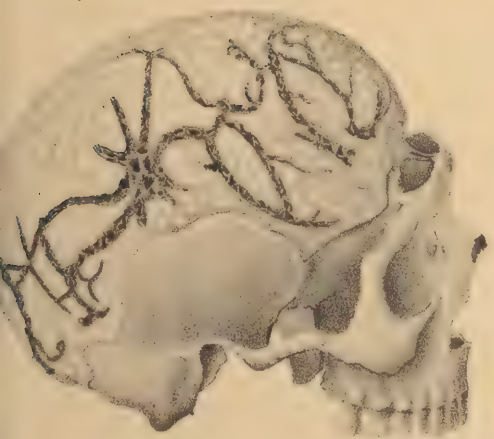


Fig. 2.

Fig. 3.

Fig. 4.

E.Prescott M.D. pinx.

PLATE II.

Infiltrated and Encysted Tubercles of the Head of the Femur.

Fig. 1. Numerous crude, disseminated tubercles are shown in the cancellæ of the head and neck of the femur. A vertical section of the bone with the section turned to one side exhibits the relation of the parts. Thickening of the septæ of the cancellæ—or the trabeculæ of the bone—similar to induration or hepatization of the lung tissue—is quite apparent, inducing solidification, increased weight, and, at the surface points exposed to friction, creating *eburnation* or ivory-like formation of the bone. The tubercles are seen in the centre of the cancellated tissue of the head and neck of the femur, and when softened can only be evacuated by the pus travelling to the surface of the bone and finding its exit either within or without the attachment of the capsular ligament, thus creating inter- or peri-articular abscess.

From Femurs No. 102, M. Cabinet.

Fig. 2. A similar section of another tuberculous femur exhibiting tubercular cavities of different dimensions in the cancellated structure of the head and neck of the bone. These abscesses have discharged through numerous small perforations on the surface of the head of the bone after inducing loss of vitality—softening and so-called ulceration of the articular cartilage. The change in the spherical head of the femur consequent on the fatty degeneration, etc., attendant on the progress of tubercle, is apparent. The induration of the trabeculæ of the adjacent cancellæ is also seen.

From Femurs No. 98, M. Cabinet.

PLATE II.

Fig. 1.

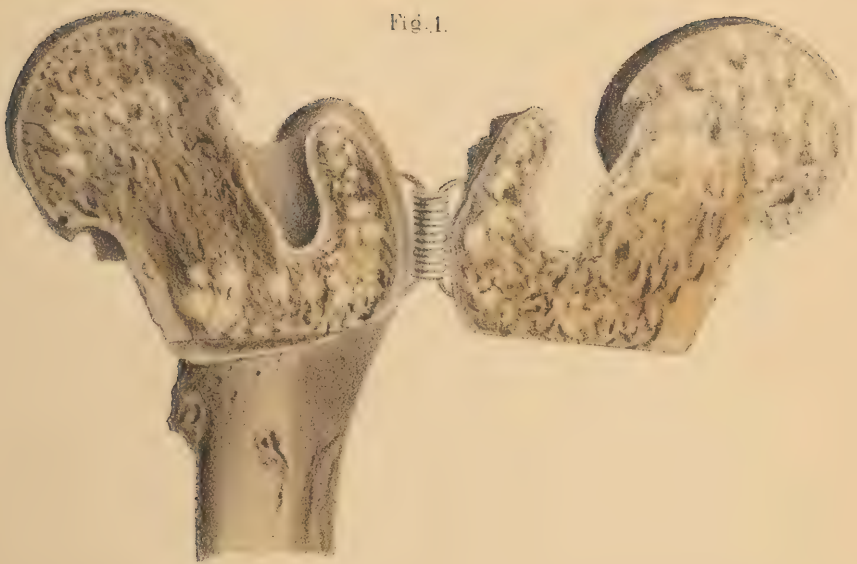
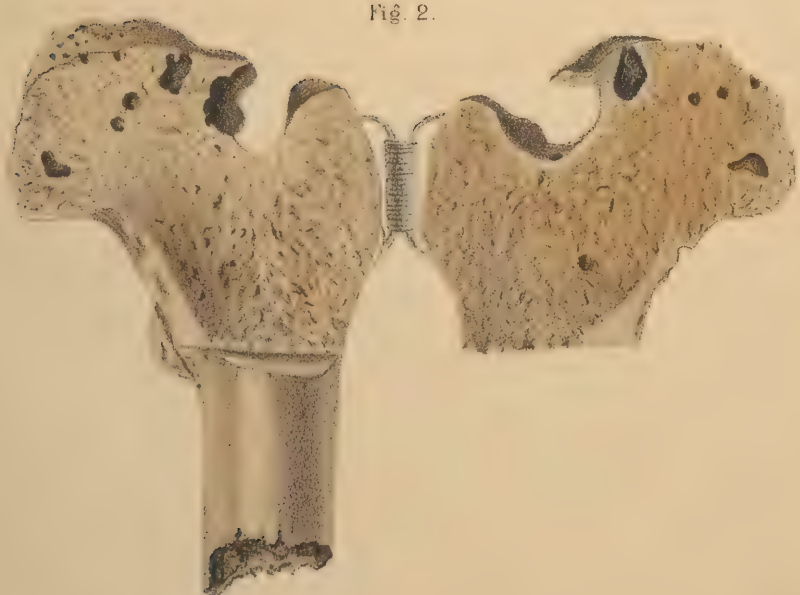


Fig. 2.



H. Prueger M.D. pinx.

PLATE III.

Illustrations of the Effects of Tubercles of the Cancellated Tissue on the outer face of the Head and Neck of the Femur.

Fig. 1. The head of this bone shows osteophytes around the origin of the round ligament, on the inferior anterior portion of the head and around the epiphyseal junction of the head with the neck, this portion of the bone being rough and more solid than is usual in health. The round ligament has been necrosed at its origin in consequence of the cutting off of its blood-supply by the tubercles. The acetabulum has similar deposits at corresponding points, influenced probably by friction, after the loss of the articular cartilage of each bone.

From Femur No. 102, M. Cabinet.

Fig. 2. Another example of the changes produced in the head of the femur and its articular cartilage. Under the modified nutrition of the cancellated tissue created by tubercles, the head of the femur has lost its spherical shape, and the compact layer is crushed out into a bony ridge in the line of its epiphyseal junction with the neck. Numerous perforations of the surface of the head of the bone exhibit the points through which the softened tubercles have escaped into the articulation. The largest ulceration on the surface of the head of the bone communicates with a tuberculous cavity in the cancellæ beneath it.

From Femur No. 98, M. Cabinet.

Fig. 3 Tubercles in the neck of the femur having induced a modification of the normal action of the medullary tissue, fatty degeneration, softening, and the formation of lactic acid have created disintegration and absorption of the neck. The head, by muscular pressure against the acetabulum, has been forced to the trochanteric extremity of the neck, thus creating marked shortening of the neck and bringing the trochanters near to the margin of the acetabulum from muscular action. Tuberculous ulcerations of the head, show where the exit of the softened tubercles has occurred into the articulation. These ulcerated points are most numerous on the superior face of the femur, where it presses against the acetabulum in sustaining the weight of the body.

From Femur No. 91, M. Cabinet.

Fig. 4. A marked example of the changes created in the shape of the head and neck of the femur by tubercles. The spherical form of the head is greatly changed—the epiphyseal line is hypertrophied and ulcerated into several deep notches, whilst large ulcers of the surface of the head indicate the tuberculous cavities existing in the cancellæ of the neck and the escape of the softened tubercles. Numerous similar ulcerated points are seen on the trochanteric portion of the neck, resulting from the destructive action induced by disseminated tubercles, without evidencing by "periostitis ossificans" any effort at repair. The trochanters and upper portion of the shaft of the bone, as is generally the case, do not appear to have been involved in the diseased action.

From Femur No. 90, M. Cabinet.

PLATE III.

Fig. 1.

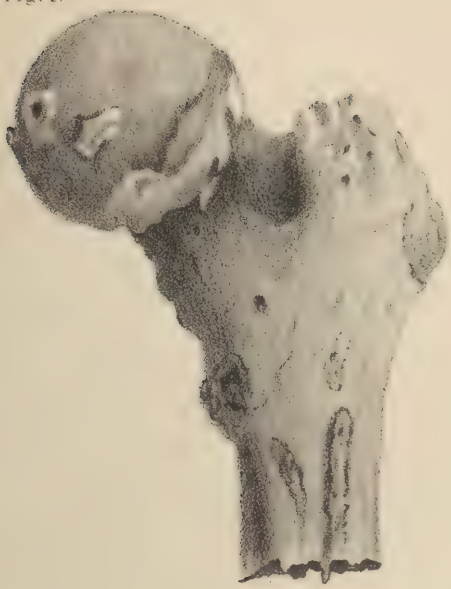


Fig. 2.

Fig. 3.

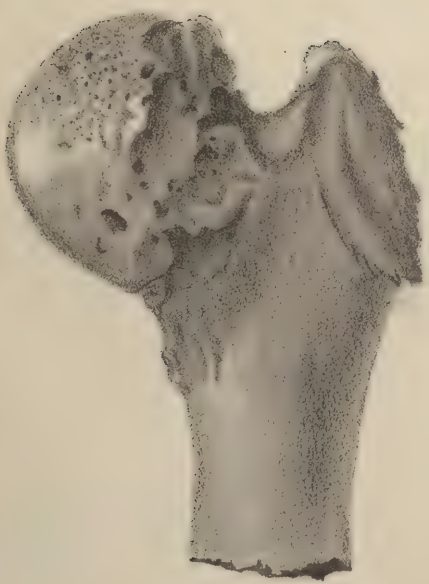


Fig. 4.

R. Prueger M.D. pinx.

PLATE IV.

Tuberculur Cavities in the Head of the Femur.

Fig. 1. A vertical section of the femur, represented in Plate III, fig. 3, shows the changes in the cancellated tissue and the cavities corresponding with the ulcerated points seen on the surface of that bone. The septæ around the cancellæ are hypertrophied; the entire structure is thickened and unnaturally indurated or solidified. Some of the cavities show the thickened edge, similar to the false membrane lining a pulmonary abscess, the vascularity of the adjacent tissue being also increased. The softened and cheese-like cancellæ give evidence of fatty degeneration in the greasy appearance and touch, when recent.

From Femur No. 91, M. Cabinet.

Fig. 2. A beautiful example of the changes in the head of the femur caused by *Arthritis Coxæ Tuberculosa*. The spherical shape of the head is changed, several deep ulcers indicate the cavities and other changes in the cancellæ; whilst the induration caused in the reparative effort near the margin of the largest cavity, has developed an ivory-like structure, that by friction against the corresponding surface of the acetabulum has become "*eburnated*." The neck is somewhat atrophied and shortened, and a new ossification near the insertion of the capsular ligament indicates the reparative efforts of nature.

From Femur No. 28, M. Cabinet.

Fig. 3. A vertical section of Fig. 2, exhibiting the changes in the interior of the bone. At a point corresponding with the largest exterior ulceration, shown in Fig. 2, we note a large tubercular cavity caused by the molecular necrosis of the cancellæ of this part, having a well-defined margin like an indurated lining to a pulmonary cavity. The flattening of the head of the femur; the extended margin of the epiphyseal line; the shortening of the neck; the induration (hepatization) of the surrounding structure, and the marked trabeculi, are also seen.

From Femur No. 28, M. Cabinet.

PLATE IV.

Fig. 1.

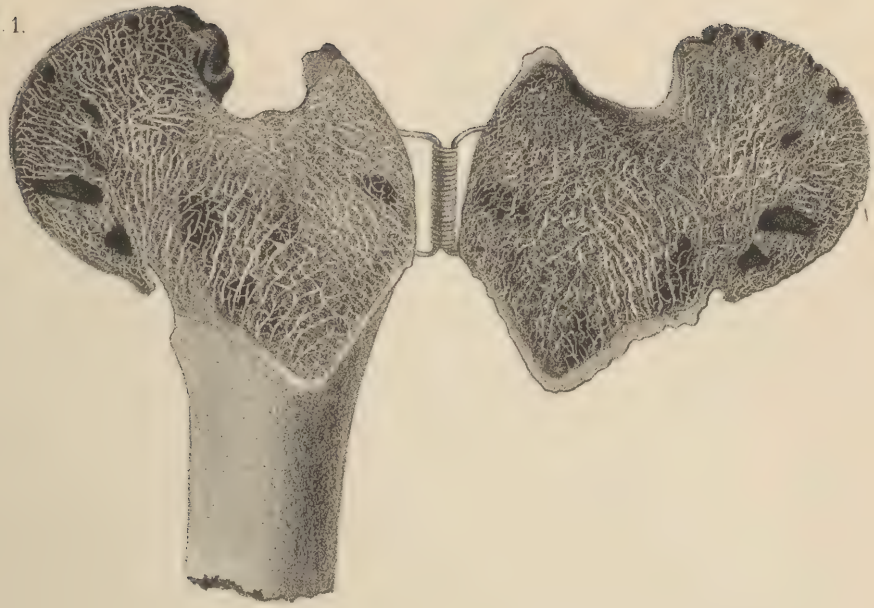


Fig. 2.

Fig. 3.

E. Prueger M.D. pinx.

PLATE V.

Changes in the Acetabulum and Head and Neck of the Femur, induced by Tubercles.

Fig. 1. An exterior view of the left Innominatum, showing the changes induced in the acetabulum by "hip-disease." Under tuberculous influence the margin of the acetabulum has become ulcerated, and a few osteophytes have been created, rendering it rough and spinous. The articular cartilage of the acetabulum having been eroded ("chondro-necrosis") and the head of the femur having likewise been exposed, the superficial layer of the head of the femur has adhered to or become anchylosed with the bottom of the acetabulum. Muscular action having ruptured the union of the exterior face of the head of the femur, the latter remains *in the acetabulum* and partially fills it up, a portion of the femur subsequently moving in it, as in pseudarthrosis.

From I. Femur No. 21, M. Cabinet.

Fig. 2 Exhibits the Femur of the same preparation as Fig. 1, above. The neck of the femur, having undergone tuberculous degeneration, has been largely absorbed at its base, and the head of the bone has been depressed and rests upon the trochanter minor, the shaft of the femur being drawn towards the crest of the ilium, whilst a portion of the head remains in the acetabulum. The ulcerated points on the surface of the head, where the outer lamina has been removed by adhesion to the acetabulum and the ossification connected with the effort at repair, are also seen.

From I. Femur No. 21, M. Cabinet.

Fig. 3. View of the Acetabulum of the right innominatum, to which the femur shown in Fig. 2, Plate IV, belongs. Although the head of this femur was so much diseased, the acetabulum as yet is but slightly affected. The osteophytes on the anterior superior rim of the acetabulum are well developed, and ulcerations of the other portions are apparent. At the superior anterior edge of the acetabulum, directly under the projecting osteophytes, the acetabulum is partially eburnated, though this is not seen in the drawing. The eburnation of the acetabulum corresponds in position with that seen on the head of the femur. The depth of the acetabulum in this preparation is augmented by the osteophytes on its rim.

From I. Femur No. 28, M. Cabinet.

Fig. 4. The Femur in "arthritis coxæ tuberculosæ," being luxated on the dorsum ilii, has become anchylosed there. The outer lamina of the head of the femur has then separated from the remaining portion and a false-joint has been established. The acetabulum has been greatly diminished in size by ossific deposits. The pelvis and spinal column deviate to the side of the hip-disease.

From I. Femur No. 15, M. Cabinet.

PLATE V.

Fig. 1.

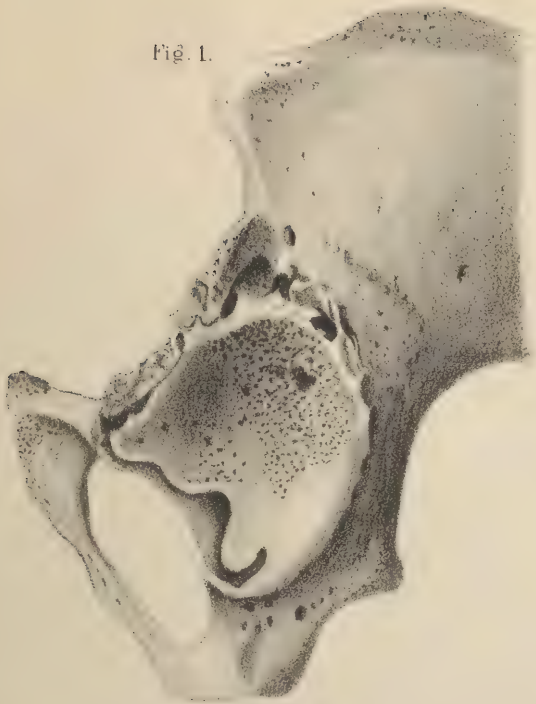


Fig. 2.

Fig. 3.

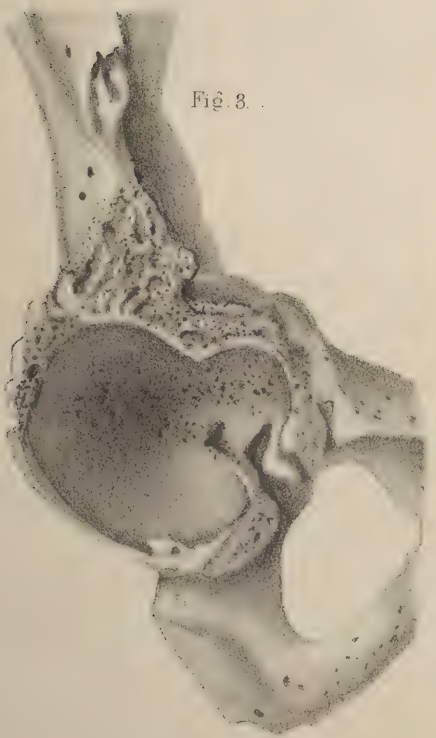


Fig. 4.

R. Praeger M.D. pinx.

PLATE VI.

Illustrations of Tubercular Disease of the Vertebræ.

Fig. 1. A view of the normal structure of a Vertebra and inter-vertebral cartilage, showing the epiphyseal margin of the face of the body of the vertebra. The lower portion of the drawing exhibits the superior and inferior inter-vertebral cartilages, showing the soft central portion. The thick edges of the cartilages have a close attachment to the epiphyseal margin of the vertebra just alluded to, and derive their blood supply mainly from it. The central portion of the drawing shows the condition of a vertebra in the early months of infancy, the body of the vertebra being the small round central portion of the drawing; the spinous process is opposite to it, and the bony arches of the spinal canal intermediate to both; all these processes often not being fused together till the fifteenth year.

From Preparation No. 403, U. P.

Fig. 2. An illustration of the results of tubercles in the dorsal portion of the vertebral column. Bony spines (osteophytes) extend from one epiphyseal margin of a vertebra to another. The ulcerated openings through which the tuberculous pus and molecularly necrosed bone have been discharged, are seen, and a white spot in the second of the bones is the end of a loose sequestrum. Attention is called to the smooth and defined edges of the openings in the bodies of the vertebræ, which differ greatly from the superficial and apparently worm-eaten edges attendant on Caries. The diseased action in this example of tubercles, as in others, has evidently travelled from within the cancellated tissue, *outwards*, and not from the surface, inwards, as in Caries. Anchylosis has enabled the diseased vertebræ to sustain the weight resting on the spinal column at this point.

From Preparation No. — of Vertebræ, M. Cabinet.

Fig. 3. A view of the extensive destruction sometimes caused by Tubercles of the dorsal vertebræ. The numerous well-defined orifices of tubercular cavities in the cancellated tissue; the entire destruction of one and nearly all of the body of another vertebra—the part being sustained in the preparation by a rod; the approximation of the ribs from the change of the vertebral column and the soundness of the half arches and processes of the vertebræ whose bodies have been destroyed, are also shown.

From Preparation No. 65, M. Cabinet.

Fig. 4. Another example of Osteophytes of the vertebral column, each of which arises from the epiphyseal margin of one vertebra and extends to that of another, thus strengthening the bodies in the process of repair. Several points of tuberculous ulceration, are seen on the front of the vertebræ.

From Preparation No. 77, U. P.

PLATE VI.

Fig. 1.

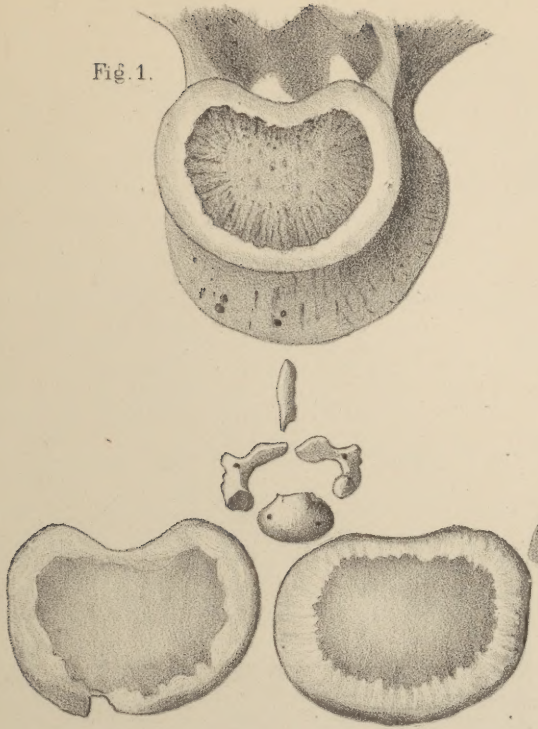


Fig. 2

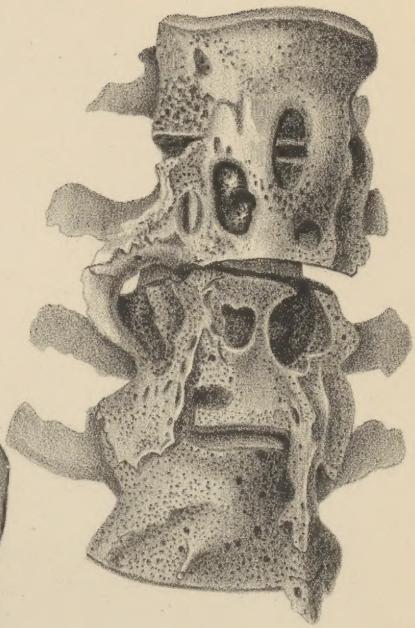


Fig. 3.

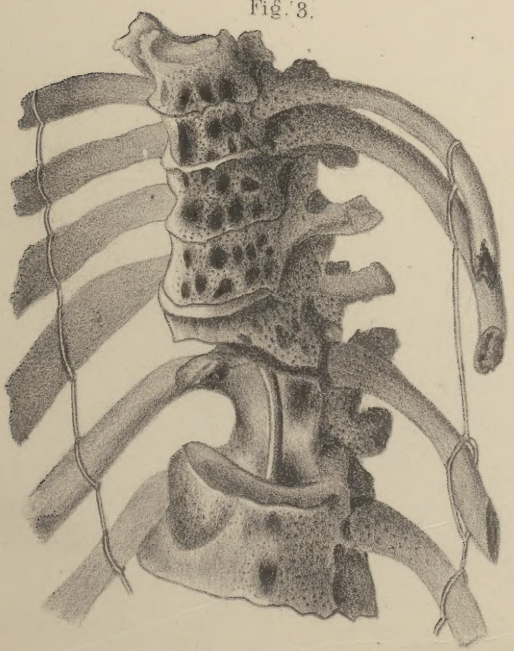
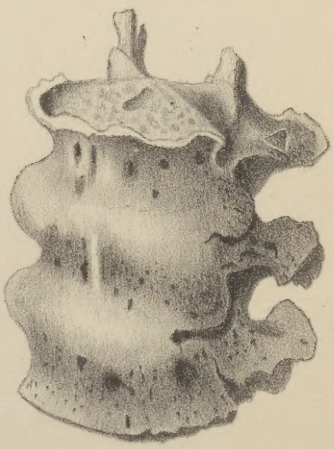


Fig. 4



H.Praeger M.D. pinx.